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BEHAVIORIAL INFLUENCE MODELING AND SIMULATION

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1.0 SUMMARY

In the context of the overall Warfighter Interface Research and Technology Operations (WIRTO) research, this task focused on supporting research in cognitive modeling and dynamic visualization of understanding. Models of tacit knowledge need to be visualized in a format that provides analysis, comparison, manipulation, and recognition of that knowledge. Research into data collection tools and translation services was executed. Results are provided.

2.0 INTRODUCTION

The Polyhedral Dynamics Analysis Tool (PDAT) was modified to incorporate scenario data and analysis. Scenario data is generated from scenario runs using OMAR (Operator Model Architecture) and Neverwinter's Night (NWN). PDAT will provide tools to analyze knowledge models and recognize knowledge patterns. Research into data collection tools and translation services was executed.

3.0 METHODS, ASSUMPTIONS AND PROCEDURES

3.1 Scenario Generation and Display

Scenarios are run using Operator Model Architecture (OMAR) to send commands to Neverwinter's Night which displays the scenario in a virtual environment.

3.1.1. OMAR

OMAR (omar.bbn.com) is a software suite that supports the development of simulation and agent-based systems. OMAR is the driver for the scenarios that have been developed. The two main functions are to send and receive data on the scenario to NWN, and to output the results of the scenario into a scenario (.scn) file for use in the PDAT application.

3.1.2. NWN

NWN is a software application that provides a virtual environment for our scenarios. Virtual environments have been generated in the application to simulate our generated scenarios. Agents are controlled via command from the OMAR application, and results of the actions are returned to OMAR for recording. Figures 1, 2, and 3 have examples of the office virtual environment that was generated.

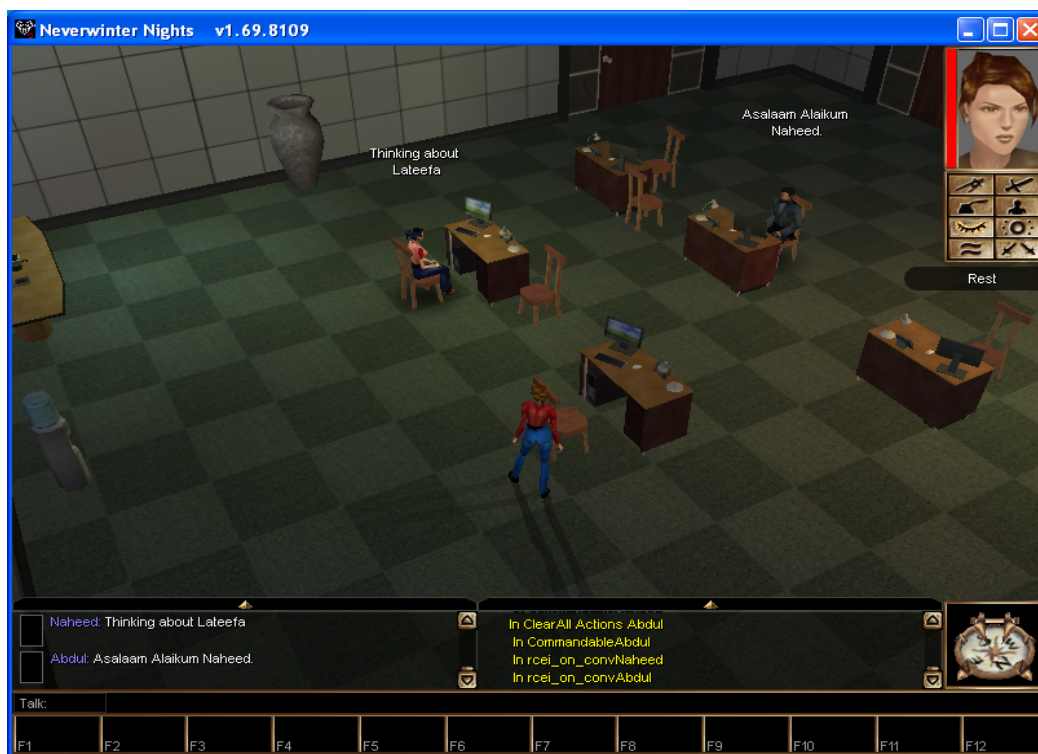


Figure 1: NWM



Figure 2: NWN Office



Figure 3: NWN Conversation

3.2 Analysis Application

Analysis of the scenario is performed by the PDAT application.

3.2.1. PDAT

PDAT was updated to handle scenario data that come from the OMAR/Neverwinter Night's scenarios.

3.2.2. Scenario Tools

In order to fully use the data provided in the scenario files, there were a number of scenario tools that were added for use in PDAT. These tools include Run Scenario, Manual Scenario, Single Session Comparison, Dual Session Comparison, and Dual Side By Side Comparison.

3.3 Researching Categorization and Stereotyping

Research was conducted to expand the scenarios with better knowledge models.

3.3.1. Data Collection

A collection tool was needed to gather data for future knowledge models.

Criteria for data collection tool: A variety of criteria was used to select the software used for data collection. They included:

- Response Count
- Data Format
- Languages Supported

- Software documentation
- Extensible
- Clean display
- Software support
- Cost

The data collection software was evaluated against these criteria. Any tool that didn't meet the first three criteria was thrown out, as it would be unable to accomplish the tasks required. Once a tool met these main requirements, it was tested on how well it met the other requirements and how difficult it would be to overcome any deficiencies.

Data Collection Options: In all, 24 data collection tools were evaluated for potential use. Seven were selected for final analysis and 17 options were discarded for failing to meet a required specification. The 17 discarded tools were Digivey, Fluid Surveys, Inquisite, Survey Systems, Survey Pro 5, Global Park, Cvent, Blue/Surveys, Checkbox Survey Online, Checkbox Survey Server, Cogix ViewsFlash, Feedback Server On-Demand, Feedback Server On-Site, KeySurvey, phpESP, StatPac, and Survey Said. The seven selected tools are detailed in the following sections.

Lime Surveys: Lime Surveys is a free on-line survey package with unlimited surveys and responses. It has adequate data output formats and can prevent someone from taking the survey multiple times. The tool is basic, and it may not cover all the languages needed for this research. The question types are limited.

See URL: <http://www.limesurvey.org>

Qualtrics: Qualtrics is an on-line survey that provides a large number of features including an extensive question type selection, language support, and an on-line library of tips and support. Even with purchase, there is a limited number of responses allowed, and only one user may edit the surveys.

See URL: <http://www.qualtrics.com/survey-software/>

Snap Surveys: Snap Surveys provides two options, a survey hosted on-line or a downloadable survey to host on your own server. It covers the languages needed and has acceptable output formats. The cost is high in comparison to the quality of the surveys, and the software does not provide any time controls.

See URL: <http://www.snapsurveys.com/us/>

Survey Gizmo: Survey Gizmo provides usable data output formats along with unlimited surveys and language support. Timing controls are lacking, and does not provide translations.

See URL: <http://www.surveygizmo.com/>

Survey Monkey Pro: Survey Monkey Pro is an application that was recommended by co-workers who currently use it. It provides 1000 responses at a low monthly cost. It is also easy to use. It provides great service for the basic features, but is not extensible enough to provide the controls needed for the research.

See URL: <http://www.surveymonkey.com>

Toluna: Toluna is a company which has a basic survey tool with few features. Toluna may be a great resource in panel procurement if needed in the future. The lack of features make this tool unacceptable for our use.

See URL: <http://www.toluna-group.com>

Zoomerang: Zoomerang provides unlimited surveys and responses. It can display images, but not video. It can be used in a kiosk version and provides adequate data output formats. It cannot control time. It also does not support all the languages we need, and only allows for one user.

See URL: <http://www.zoomerang.com/online-surveys/>

3.3.2. Translation

The surveys will be conducted in a number of different languages, so a translation tool will be needed.

Criteria for Translation Tool: A variety of criteria were used to select the software for data collection. The criteria included:

- Languages Supported
- Human Translated vs. Machine Translated
- Amount of time required for translation
- Cost

The data collection software was evaluated against these criteria. The four language translations that the software must provide are Chinese, Urdu, Sanskrit and Hindi. Human translations will be better for sentences, but machine translation may be adequate for some of the one word responses.

To receive an adequate quote on cost and time, the number of words requested was 1000 for each of the required languages.

Translation Options: There were six evaluated services that provide human translation of the four languages, and three machine translation tools that provide translations for three of the languages (sans Sanskrit). A breakdown is shown in Figure 4.

Human Translation Options: The human translation options are Advanced Language, AltaLang, Betmar, Lionbridge, Transperfect, and Verbatim Solutions.

Machine Translation Options: The machine translation options are Ace Translator, Babylon and Google.

Translation Services

ID	Service Name	Website	Cost	Notes	Software
9	Verbatim Solutions	http://www.verbatimsolutions.com/ <input checked="" type="checkbox"/> Chinese <input checked="" type="checkbox"/> Urdu <input checked="" type="checkbox"/> Sanskrit <input checked="" type="checkbox"/> Hindi	\$160, \$220, \$210, \$220 Total: \$810.00	2-3 Day completion	<input type="checkbox"/>
16	Transperfect	http://www.transperfect.com/ <input checked="" type="checkbox"/> Chinese <input checked="" type="checkbox"/> Urdu <input checked="" type="checkbox"/> Sanskrit <input checked="" type="checkbox"/> Hindi	\$200, \$290, \$290, \$290 Total: \$1,070.00	5 day complete	<input type="checkbox"/>
12	Advanced Language	http://advancedlanguage.com <input checked="" type="checkbox"/> Chinese <input checked="" type="checkbox"/> Urdu <input checked="" type="checkbox"/> Sanskrit <input checked="" type="checkbox"/> Hindi	\$1075 Total: \$1,075.00	3-5 day complete	<input type="checkbox"/>
11	AltaLang	http://www.altalang.com <input checked="" type="checkbox"/> Chinese <input checked="" type="checkbox"/> Urdu <input checked="" type="checkbox"/> Sanskrit <input checked="" type="checkbox"/> Hindi	\$200(s)/\$240(t), \$260,\$480,\$260 Total: \$1,240.00	3 day complete	<input type="checkbox"/>
3	Betmar	http://www.betmar.com <input checked="" type="checkbox"/> Chinese <input checked="" type="checkbox"/> Urdu <input checked="" type="checkbox"/> Sanskrit <input checked="" type="checkbox"/> Hindi	\$595, \$625, \$625, \$625 Total: \$2,470.00		<input type="checkbox"/>
7	Lionbridge	http://www.lionbridge.com/lionbridge/en-US/services/loc ? <input checked="" type="checkbox"/> Chinese <input checked="" type="checkbox"/> Urdu <input checked="" type="checkbox"/> Sanskrit <input checked="" type="checkbox"/> Hindi	?	Requested info, have not heard	<input type="checkbox"/>
4	Google	http://translate.google.com/ <input checked="" type="checkbox"/> Chinese <input checked="" type="checkbox"/> Urdu <input type="checkbox"/> Sanskrit <input checked="" type="checkbox"/> Hindi	Free Total: \$0.00		<input checked="" type="checkbox"/>
13	Ace Translator	http://www.acetools.biz/ <input checked="" type="checkbox"/> Chinese <input checked="" type="checkbox"/> Urdu <input type="checkbox"/> Sanskrit <input checked="" type="checkbox"/> Hindi	\$59.95 Total: \$59.95		<input checked="" type="checkbox"/>
8	Babylon	http://www.babylon.com/ <input checked="" type="checkbox"/> Chinese <input checked="" type="checkbox"/> Urdu <input type="checkbox"/> Sanskrit <input checked="" type="checkbox"/> Hindi	\$9.70 a month, \$118 lifetime Total: \$118.00		<input checked="" type="checkbox"/>

Figure 4: Translation Option Table

4.0 RESULTS

4.1 PDAT Data Generator

The PDAT Data Generator takes the scenario files generated from OMAR and parses out the applicable data for use in generating a backcloth (.bclth) file for use in PDAT. The backcloth lists nodes that are elements of the scenario and places them on the graph according to the type and time of the event. The Generator can also create backcloth files without loading a scenario file, but the output is less sophisticated and more time intensive.

4.1.1. Main Screen

The main screen has three major sections, scenario panel, nodes panel, and the concepts panel. The scenario panel is used to load the scenario file. The concepts (agents) can be selected on load. Once loaded, the nodes and concepts are filled in. The lists can be modified in each respective panel. Once the data is correct, the user saves the data into a backcloth file.

4.1.2. Backcloth File

The backcloth file is generated by the PDAT Data Generator, and loaded by PDAT. The file is xml based, and it contains the nodes and concepts that will be graphed. Along with the nodes and concepts is the scenario data. The scenario data lists nodes and concepts, along with the time at which they are activated. The order of the nodes also determines the path that is graphed. The node and concept list contain all the possible activation nodes and concepts, but each scenario within the file may use a smaller percentage of them.

4.2 PDAT

4.2.1. Main Screen Display

The main screen (Figure 5) is made up of five elements: Menu, Tool Bar, Graph, Data, and Status Bar. This design has the main elements displayed (graph, concept, and node lists) with other features one to two clicks away.

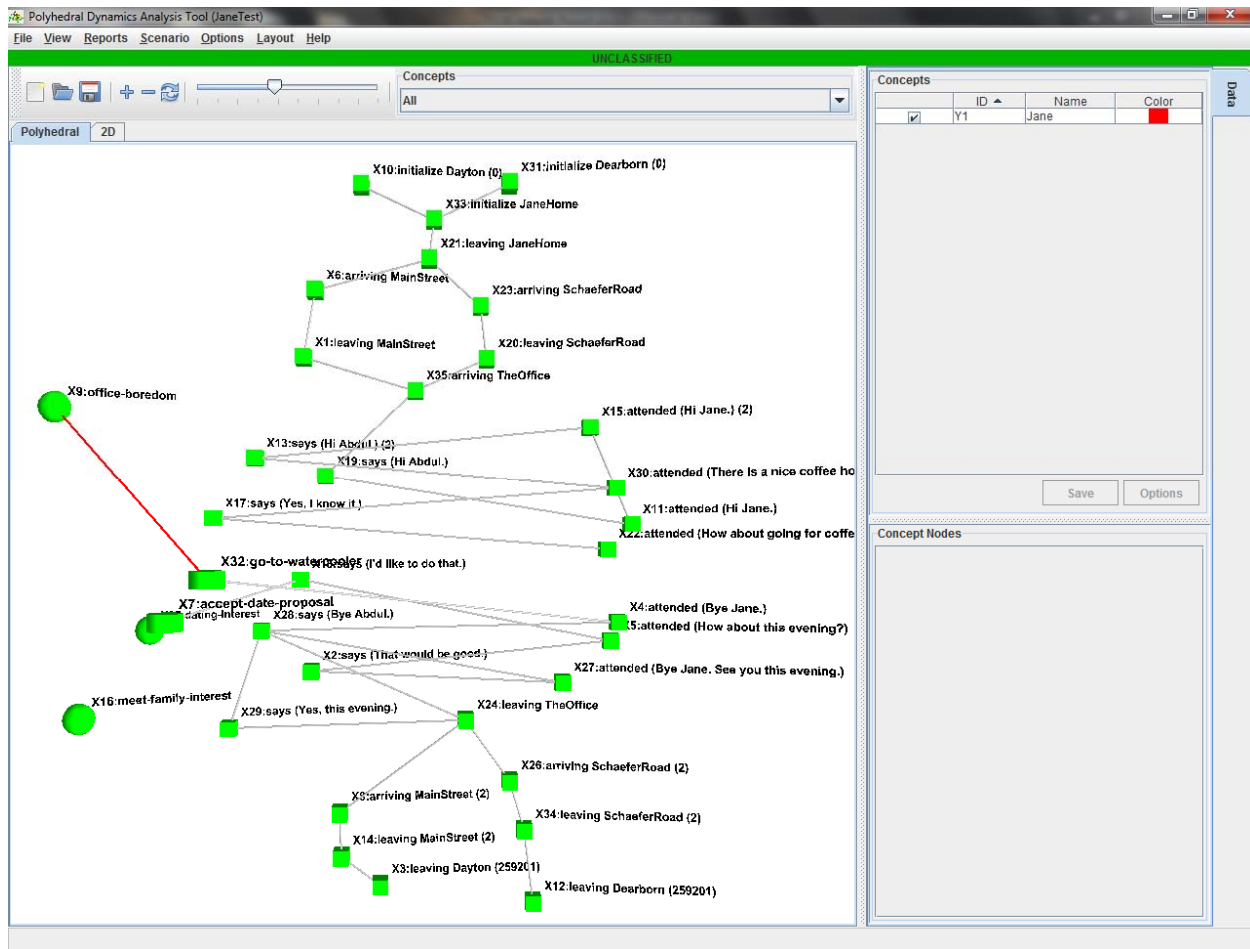


Figure 5: PDAT Application

4.2.2. Menu

The menu (Figure 6) has seven menu items: File, View, Reports, Scenario, Options, Layout, and Help. The File menu contains the file load/save actions for the application. The View menu has viewing selections for the application. The Reports menu list reports for the applications, broken up in four sections: Graph Data, Node, Edge and Concepts. All scenario tools are found under the Scenario menu. Application options are in the Options menu. The different layouts in which the graph can be generated are in the Layout menu. The Help menu contains the various help features.

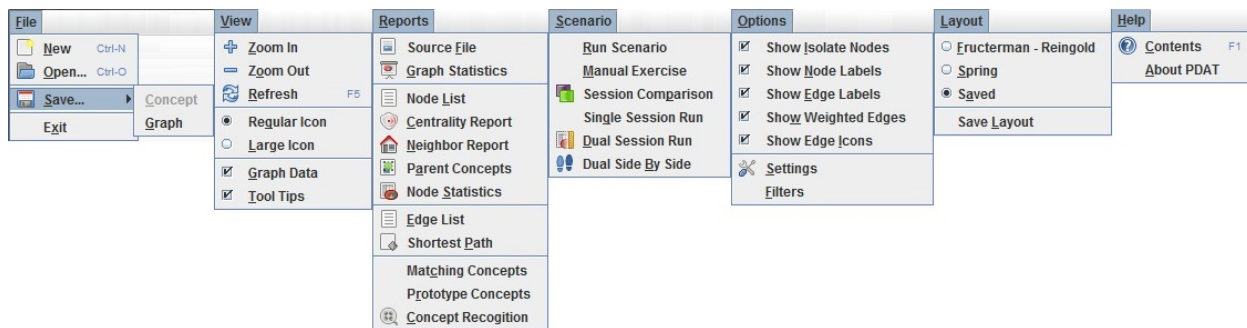


Figure 6: Menu

4.2.3. Tool Bar

The tool bar (Figure 7) has quick launch icons for the application. It also contains some graph manipulation tools, such as zoom and node sizing. The quick launch icons contain some of the menu items. The last element is the Concepts combo box.



Figure 7: Tool Bar

4.2.4. Graph

The majority of the application display is the graph itself. The graph can be built in two different ways, Polyhedral and two dimensional (2D) (Figure 8). The polyhedral will be a three dimensional display of the graph. The 2D is a two dimensional display of the graph. 2D displays typically generate faster than polyhedral displays.

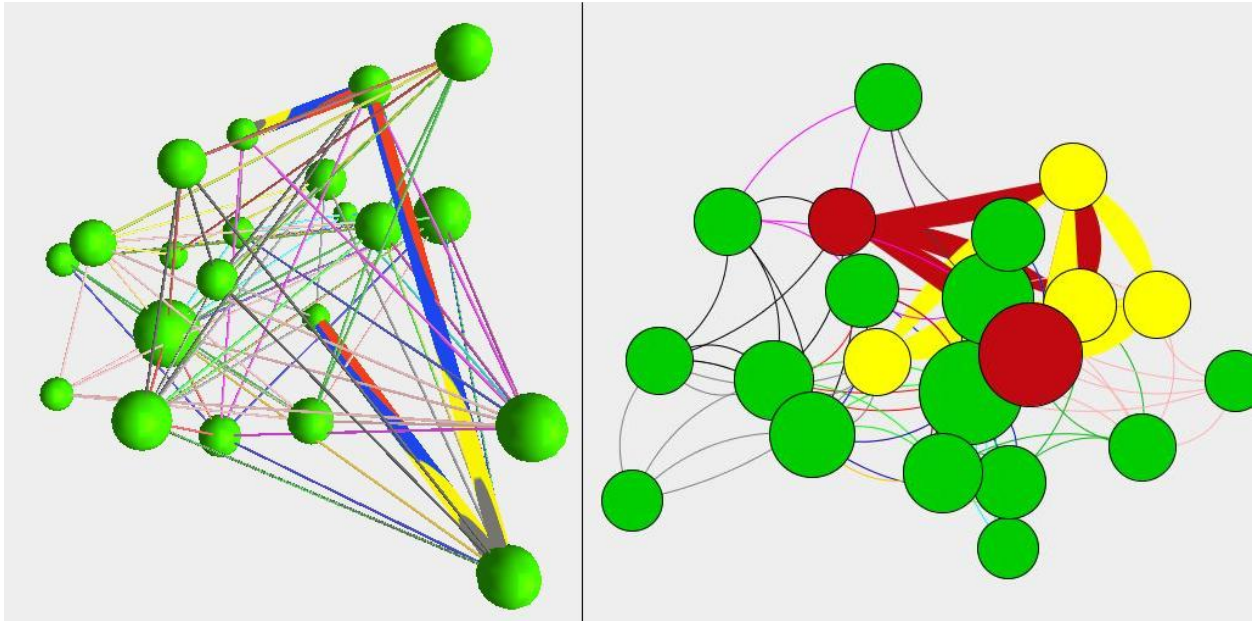


Figure 8: Polyhedral Graph vs. 2D Graph

4.2.5. Data

The right side of the application contains the graph data. It is split into two lists: concepts and concept nodes. The concept list has all concepts that are used to build the graph. The concept node list populates with data when a concept is selected. The lists provide some functionality, mainly centering selected nodes and highlighting selected concepts. Concepts can also be modified through this display.

The right side of the application can display reports/tools, depending on whether reports are generated as pop-ups or tabs on the right side.

4.2.6. Status Bar

The status bar sits at the bottom of the application. It displays information and warnings about the application. Information is displayed for a given amount of time and displays information such as node data and load status. Errors display in red, without a timer, and inform the user of a failure in the application, such as a file that did not load correctly.

The status bar also displays progress for those functions which are time consuming, such as drawing a large graph, or loading data.

4.2.7. Scenario Tools

The Scenario menu contains six different tools for the application. These tools are similar to the reports; they can be displayed as a tab or in their own window. The scenario tools provide two key functions: displaying graph activation from the provided scenario and analysis of the scenario.

Run Scenario: Run Scenario (Figure 9) is an application that takes Scenario files (.scn) that were generated by OMAR and allows the user to run the scenario against the backcloth loaded into the PDAT graph. Run Scenario has a number of settings for manipulation of how the scenario is run and viewed. These settings include: following scenario time, or specifying the amount of time between each event. Nodes are activated in the graph according to the specifications of the scenario, and the amount of time the node is activated can be modified.

Run Scenario can also be modified to take images for future analysis. Images can be predefined in the settings, such as after an activation event or in a constant interval. Image events can be added on the main screen for a specific time or event number.

The application is broken up into six parts: Session, Scenario, Show Node, Event, Activation and Button Panel. Session contains the session information, name, time, nodes activated and concepts activated. Scenario loads the scenario file. Show Node sets the node for display in the activation panel. Event is broken into three tabs: All, Recent and Imaging. All lists all events in the scenario. Recent lists the last event, the current event, and the next two events, with the current event larger for easy viewing. Imaging lists and modifies imaging events. The activation panel displays a line graph for Interest nodes and attribute and disposition values for decision nodes. The button panel has the settings and scenario run controls.

The application will run through the scenario, displaying each event as it is processed, and updates the graph and activation panel. Images are taken and stored in the file system for later analysis.

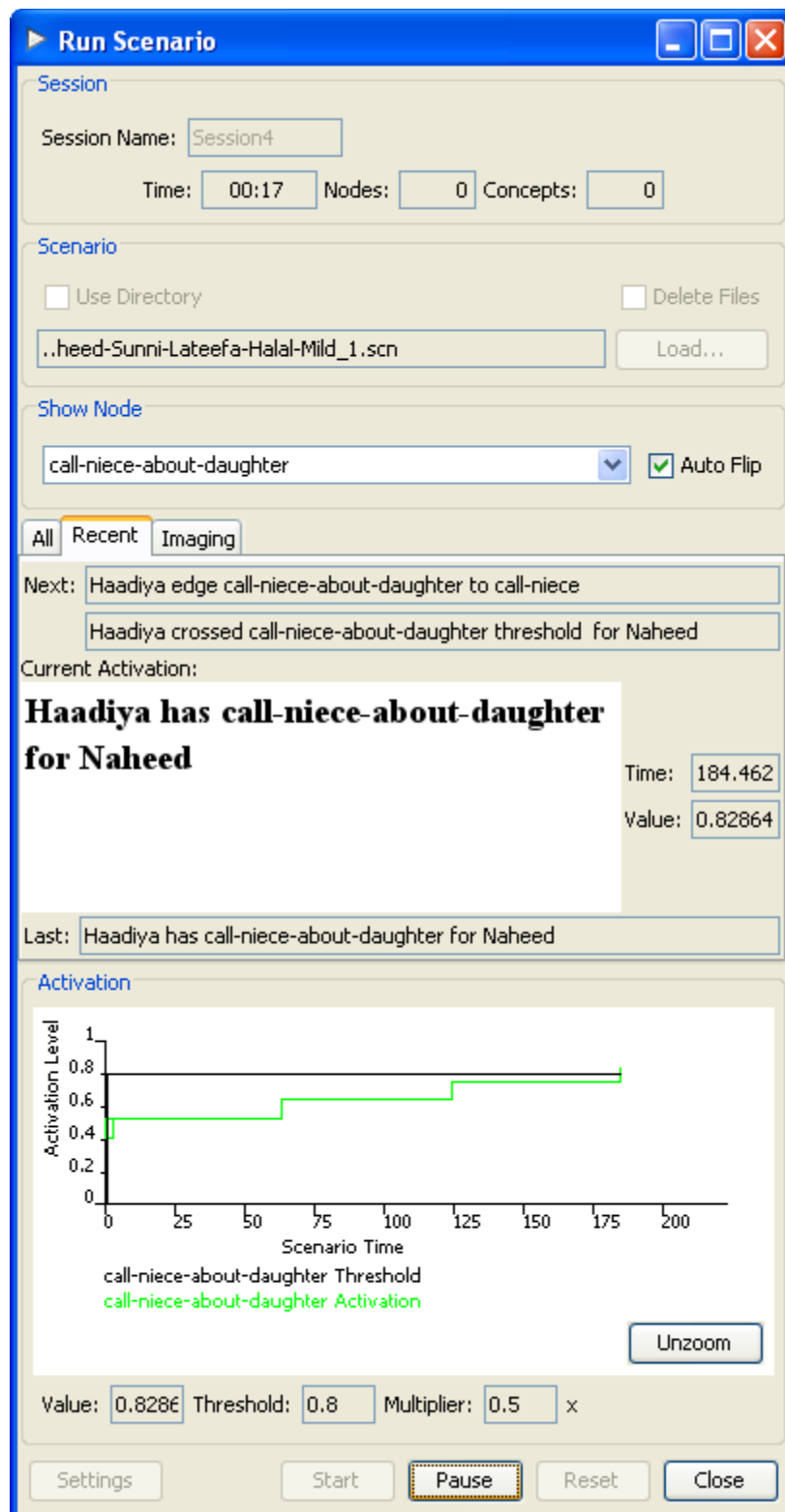


Figure 9: Run Scenario

Manual Exercise: Manual Exercise is a simple exercise tool that uses data that is completely user generated. The user creates a list of attributes to activate and sets the level of activation. Once the list of activations are created and applied, the matching concepts are listed in order of closest match. This tool can be used in defining stereotypes based on the loaded backcloth. (See Figure 10.)

Manual Exercise

Nodes

Attribute	Value
X3: Long (Hair Length)	0.7
X6: Black (Hair Color)	0.4
X12: Large (Size Of Body)	0.7
X14: No Tail (Tail Length)	0.7
X20: Forest (Where Seen)	0.7

Concepts Activated

Concept	Activation Percentage
Blk Bear	0%
Blk Lab	0%
Brn Bear	0%
Burmese	0%
Cougar	0%
Gold Lab	0%
Gold Ret	0%
Long Hair Dachshund	0%

Buttons: Save, Load, Settings, Activate, Reset, Close

Figure 10: Manual Exercise

Session Comparison: Session Comparison takes the session data saved from Run Scenario and compares it to a second set of session data. The display is broken up into three sections: a session panel, a common panel and another session panel. Each session has its own display, with the common panel containing common data in between the two. The session panel displays a graph with lists of unique activated nodes and concepts. The graph and lists are pulled from the time or event selected in the common section. If an activated node is activated in both sessions, the information is placed in the common area. (See Figure 11.)

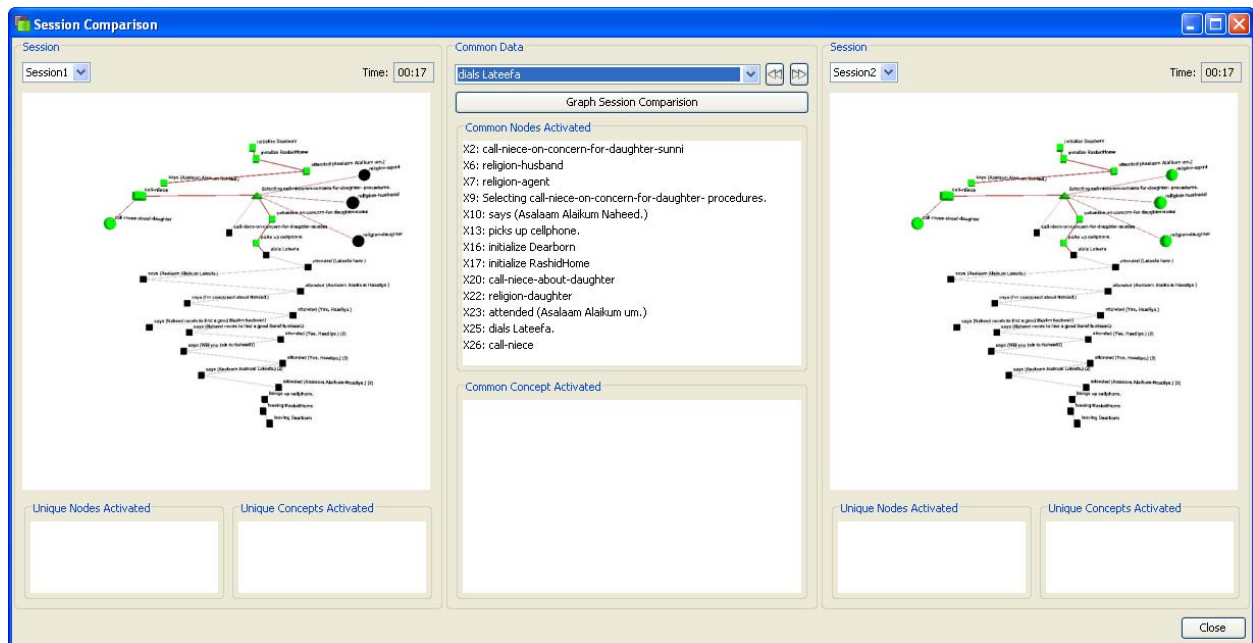


Figure 11: Session Comparison

Single Session Run: Single Session Run is very similar to Run Scenario, in that it takes a scenario file and activates the graph based on events from the scenario file. It differs in that it saves no session or image information and has no activation panel. The main difference is that it does not run through the scenario in a step-by-step, time-based manner. The user selects a range of time or events (i.e., from 1 minute to 3 minutes, or event 6 through event 12), and all nodes/concepts that are active in this range will be activated immediately. (See Figure 12.)

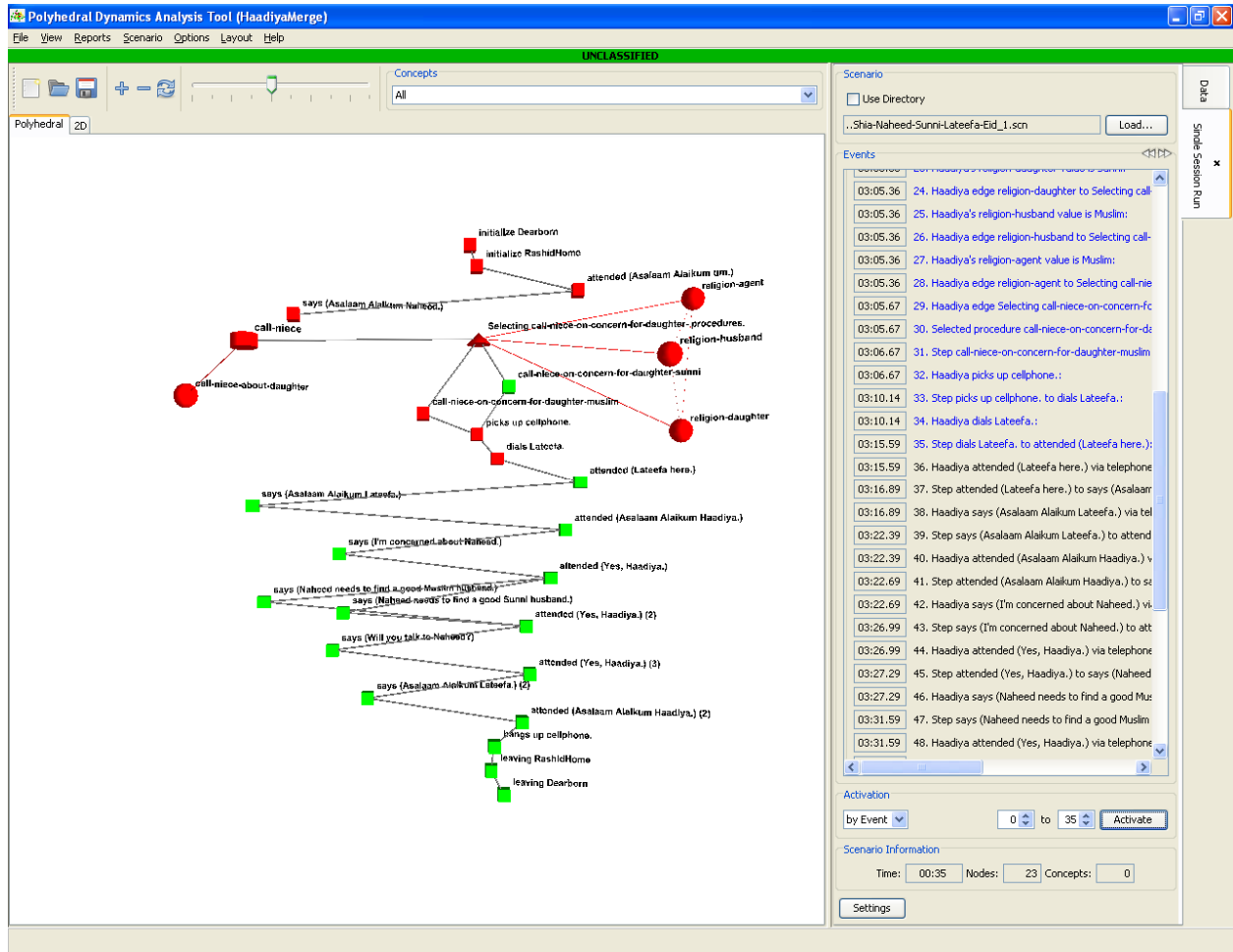


Figure 12: Single Session Comparison

Dual Session Comparison: Dual Session Comparison is similar to Single Session Run, but uses two scenarios instead of one. Like Single Session, the scenarios are loaded, the ranges are selected and the graph is updated to display the activations. Both scenarios are displayed in the same graph for comparison. The activations are in different colors, and if they both activate the same element, a third color is used to represent this. The ranges can be set to match, or each scenario can represent a different range. (See Figure 13.)

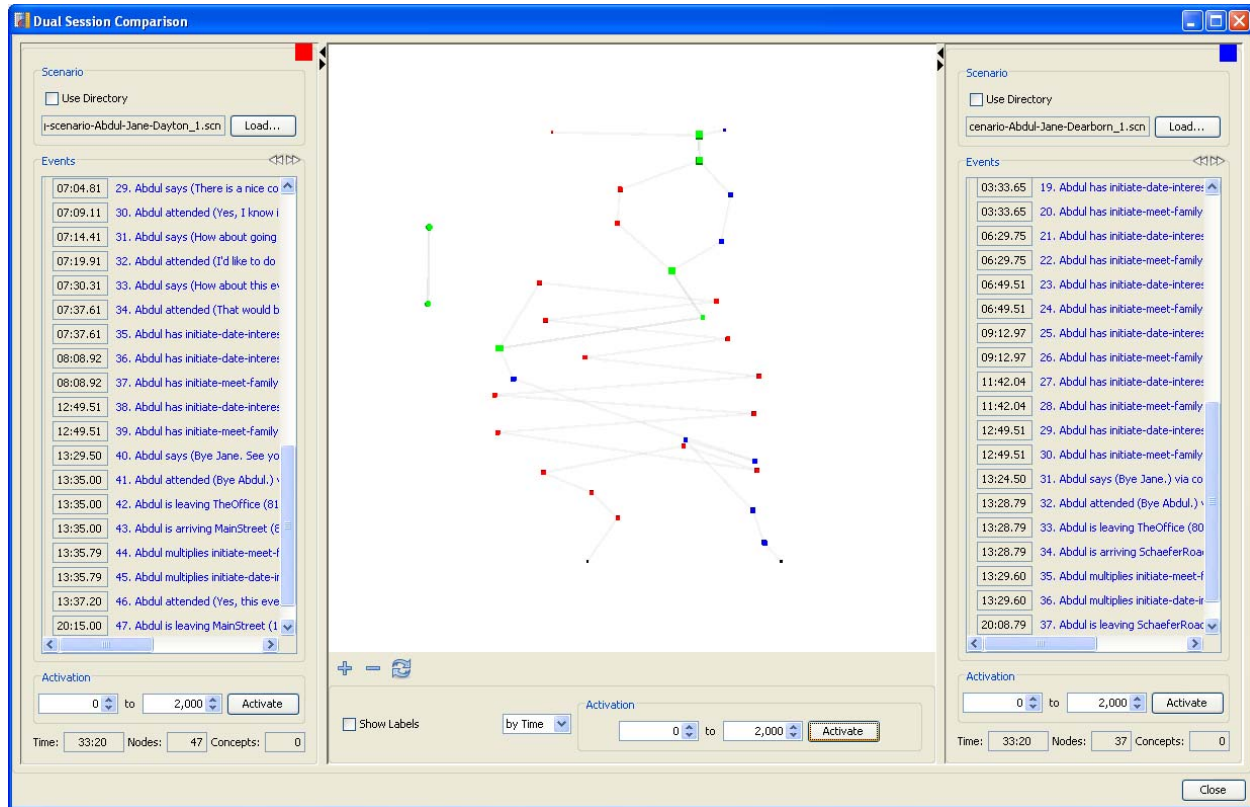


Figure 13: Dual Session Comparison

Dual Side By Side: Dual Side By Side is very much the same as Dual Session Comparison, except that each scenario displays its own graph. (See Figure 14.)



Figure 14: Dual Side-By-Side

4.2.8. Graph Manipulation

The graph display can be manipulated for better use. Each element of the graph (concepts, edges, and nodes) can be filtered out. The graph nodes can be moved around, and the graph itself can be rotated to bring other nodes to the front. Nodes can be centered on the screen, and node size can be adjusted with a slider on the tool bar. The graph nodes can be the concept nodes, or be reduced to represent the concepts themselves, linking to other concepts that share a similar concept node.

4.3 Graph Structure

PDAT can display two structure types for analysis: Conceptual and Scenario-Based.

4.3.1. Conceptual Graph Structure

The conceptual graph structure is generated from matrix (.matrix) files, or subset Node (.nodes) and Concept (.concepts) files. The graph is structured to have a number of nodes representing features or attributes, and concepts that create the edges between the nodes. Nodes have no predefined locations on the graph, but depending on the strength of the edges between nodes, they may be bunched together in the graph.

In the simple example displayed in Figure15, there are two concepts: polar bear and brown bear. The polar bear has white hair color (X4), very large (X13), long hair (X3), no tail (X14), and found in the zoo (X19). The brown bear has brown hair (X9), very large (X13), long hair (X3) and no tail (X14). Attributes that are exclusively polar bear are grouped together, and shared attributes are also grouped together.

Some assumptions might be made looking at this simple graph. The edges between X3, X13 and X14 may be stronger based on the fact that two concepts group those three together. When presented with a concept that is very large and has long hair, the graph may automatically assume the concept has no tail.



Figure 15: Conceptual Graph

4.3.2. Scenario-Based Graph Structure

The scenario-based graph structure is built from a scenario (.scn) file. The scenario based graph is different from the conceptual graph in multiple ways. First, there are multiple types of nodes in the graph. Second, the location in the graph is somewhat defined by the type of node, and the time in the scenario when the node was generated. Third, all edges in the graph are created equally. (See Figure 16.)

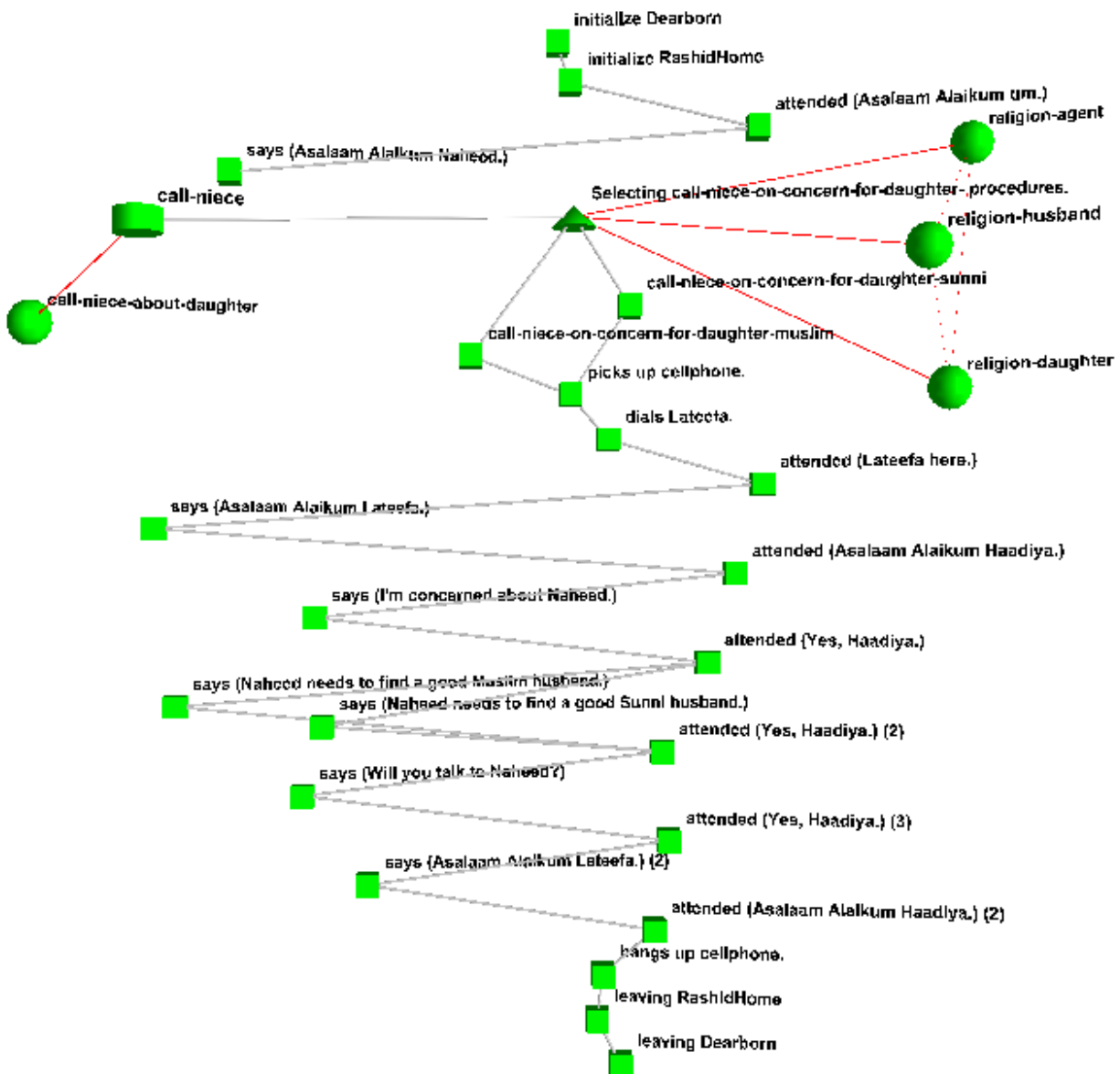


Figure 16: Scenario-Based Graph

Node Types: There are five types of nodes in the scenario based graph: Interest, Trigger, External Event, Decision, and Disposition.

Interest: Interest nodes are spherical nodes, located on the left side of the graph (see Figure 17). These nodes represent an interest of a subject that will rise and fall based on the scenario. Interest nodes have thresholds, that when met, will fire off the trigger.

Trigger: Trigger nodes are cylindrical, located on the left side of the graph, just to the right of the interest nodes. When an interest crosses a threshold, the trigger node is activated. In Figure 17, our subject reaches the threshold for calling her niece. This is the point at which the interest is so high it triggers an external action. The trigger links to the external event that occurs because of that interest.



Figure 17: Interest Trigger

External Event: External events are cubes by default (see Figure 18), except in the special case of a decision event. External events provide flow for the scenario. They are lined up sequentially from top to bottom, with the earliest events at the top. External events take up the middle sections of the graph. Within the middle section events that may be triggered on the left side, events that may affect disposition are on the right side, and everything else falls in between. Typical external events include leaving and arriving at a location, conversation (saying and hearing), and picking up the phone.

Decision: Decision nodes are special external nodes. Decision nodes are conical and are located in the middle of the graph. A decision node represents a decision point for the subject of the graph where there are multiple choices for action. The decision is influenced by the subject's dispositions. The decision node is linked to multiple other external nodes, but only one external node will be selected. In Figure 18, our subject is going to call her niece on her concern for her daughter. There are two choices: calling about her daughter's Muslim acquaintance, or her Sunni acquaintance.

Disposition: Disposition nodes are spherical nodes on the right side of the graph. Disposition nodes are attributes used by decision nodes to evaluate a situation and make a choice. In Exhibit 18, there are three dispositions: the subject's religion, the subject's daughter's potential husband's religion, and the subject's daughter's religion. They all influence the decision. If every religion is the same, the conversation may be more pleasant. If the potential husband's religion does not match their religion, the conversation may be more problematic.

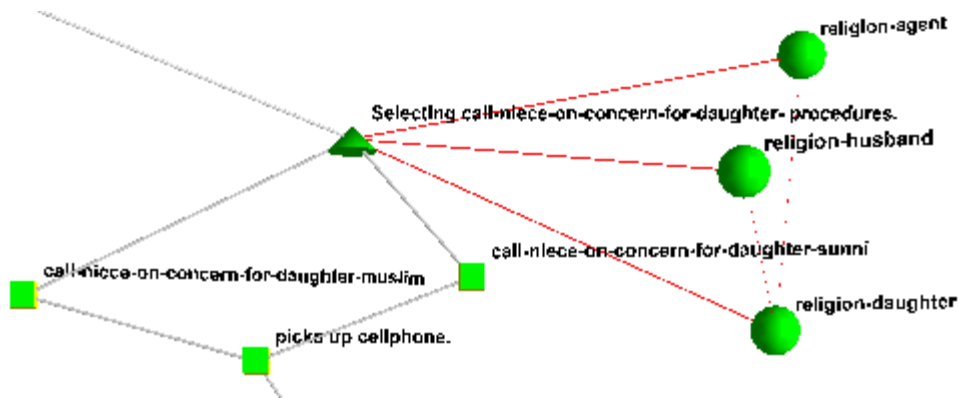


Figure 18: Decision

4.4 Data Collection Selection

Qualtrics was selected as the data collection tool. The requirements for the experiment required a number of complex features that eliminated most of the other tools. These requirements included the need to record data entry and exit times, auto-flipping to the next question after a predefined amount of time, and disabling forward and backward buttons.

4.4.1. Category Survey Collection

Qualtrics is being used to generate the survey. The survey is composed of 15 demographic questions and 60 category questions. Demographic questions are untimed, and the user can answer them at their own pace. The category questions are timed, and entry times are recorded. Users have 60 seconds for each question, with space for up to 20 categories in each question. Between each category question was a black screen that lasted for 5 seconds. The survey will take around 75 minutes.

5.0 CONCLUSIONS

The use of OMAR to run scenarios in NWN and return the results back to PDAT was successful. The result displays in PDAT are very informative, and will provide easier analysis of the data as the scenarios become more complex and lengthy. The variety of reports provides a deeper analysis that will be valuable in revealing hidden data.

The NWN displays do have their own issues. The environments can be manipulated, but when running the scenarios, you are required to have an active response to the display in order to see the events in the scenario. There have been discussions on changing the tool used for scenario display, with OpenSim being a top candidate to replace NWN. That tool will be evaluated in the future to determine if it has the functionality to replace the current simulation tool.

Data collection will start in the near future. No problems are anticipated in the retrieval of the data. The tool has been tested, and it has provided few issues. All issues were resolved with simple fixes. Qualtrics has all the necessary tools for collection according to our specific needs, including timing and automatic page change features. The results returned from Qualtrics will be analyzed and detailed in the final report.

LIST OF ACRONYMS

2D	Two Dimensional
NWN	Neverwinter's Night
OMAR	Operator Model Architecture
PDAT	Polyhedral Dynamics Analysis Tool
WIRTO	Warfighter Interface Research and Technology Operations

LIST OF GLOSSARY OF TERMS

Concept	An object made up of nodes and edges, can be identified with a unique ID. Typically a concept will have a name (i.e., Beagle), and will be visible on the graph in its own color.
Edge	An object that connects two nodes. In a concept, all nodes(attributes) of the concept will connect to each other through an edge. An edge can have a weight assigned to it, signifying the strength of the bond between the nodes that it connects.
Layout	A mechanism for returning (x, y) coordinates for nodes.
Matrix	An X by X grid of data that establishes the connection of a concept and its nodes. The matrix can also define concepts and nodes.
Node	<p>An attribute that makes up a portion of a concept. It has an ID, and typically will have a name (i.e., Brown). It is displayed on the graph as a filled circle.</p> <ul style="list-style-type: none">• Cut. A node that when removed, produces a graph with more connected components than the original graph.• Leaf. A node that has one edge• Initial. A node which a directed edge starts at.• Isolated. An unattached node which has no edges.• Normal. A node that has both incoming and outgoing edges.• Sink. A node which has no out edges. All edges connected to this node end at this node.• Source. A node which has no in edges. All edges connected to this node start at this node.• Terminal. A node which a directed edge ends at.